Engineering Physics Laboratory Manual

By

Mr M. JANAIAH
Mrs V. NIKHILA

Department of Humanities & Sciences

Sri Indu Institute of Engineering & Technology, Ibrahimpatnam.

ENGINEERING PHYSICS LAB

GENERALINSTRUCTIONS:

1. Come to Physics practical class with your observation book and completed Record book.
2. Read the instructions for the experiment to be performed in advance and prepare for the practical before to the lab.
3. The procedure will be explained in the lab .and the student has to complete the experiment in time.
4. The objective of the laboratory is learning. The experiments are designed to illustrate phenomena in different areas of Physics and to expose you to measuring instruments. Conduct the experiments with interest and an attitude of learning.
5. Know your apparatus and experimental arrangement.
6. Work quietly and carefully (the whole purpose of experimentation is to make reliable measurements!) and equally share the work with your partners.
7. Be honest in recording and representing your data. If a particular reading appears wrong repeat the measurement carefully. In any event all the data recorded in the tables have to be faithfully displayed on the graph.
8. All presentations of data, tables and graphs calculations should be neatly and carefully done.
9. Bring necessary graph papers for each of experiment. Learn to optimize on usage of graph papers.
10. Graphs should be neatly drawn with pencil. Always label graphs and the axes and display units.
11. If you finish early, spend the remaining time to complete the calculations and drawing graphs. Come equipped with calculator, scales, pencils etc.
12. Handle instruments with care. Report any breakage to the Instructor. Return all the equipment you have signed out for the purpose of your experiment.
13. The doubts & difficulties, if any, should be discussed with the concern staff immediately.
14. Understand the experiment, complete it in all respects and take signature of the concerned faculty.
15. Complete the required number of experiments and maintain good record book to get more marks in practical.

ENGINEERING PHYSICS LAB

List of experiments

1) Meld's experiment - Transverse and longitudinal modes
2) Tensional Pendulum
3) Newton's Rings - Radius of curvature of Plano convex lens
4) Diffraction Grating-Determination of wavelength of a source
5) Dispersive power of the material of a prism - Spectrometer
6) Coupled Oscillator
7) L-C-R Circuit
8) LASER
9) Optical Fiber - Bending Losses
10) Optical Fiber – Numerical Aperture

ENGINEERING PHYSICS LAB

Experiment No.1

MELDE'S EXPERIMENT

AIM : To determine the frequency of a vibrating bar or tuning fork using Melde's arrangement.

APPARATUS : Smooth pulley fixed to a stand, tuning fork, Electrical Vibrator, Connecting wires, Weight box, Pan Thread, Power supply and meter scale.

THEORY:-

(a) **Transverse arrangement:-** The fork is placed in the transverse vibrations position and by adjusting the length of the string and weights in the pan, the string starts vibrating & forms many well defined loops. This is due to the stationary vibrations set up as results of the superposition of the progressive waveform the prong and the reflected wave from the pulley. Well-defined loops are formed when the frequency of each segment coincides with the frequency of the fork. The frequency η of the transverse vibrations of the stretched string by the tension of T dynes is given by:

$$\eta = \frac{n}{2L}\sqrt{\frac{T}{m}}$$

Or ----------------(1)

$$\eta = \frac{n}{2\sqrt{m}}\frac{\sqrt{T}}{L}$$

Where,

m = mass per unit length of the string

L = length of a single loop.

(b) Longitudinal arrangement:- When the fork is placed in the longitudinal position and the string makes longitudinal vibrations, the frequency of the stretched string will be half of the frequency **(η)**of the tuning fork, That is, when well-defined loops are formed on the string, the frequency of each vibrating segment of the string is exactly half the frequency of the fork.

During longitudinal vibrations, when the prong is in its right extreme position the string corresponding to a loop gets slackened string moves upto its initial horizontal position & becomes light. But when the prong is again in its right extreme position, thereby completing one vibration, the string goes up; its interia carrying it onwards and thereby completes only a half vibration.

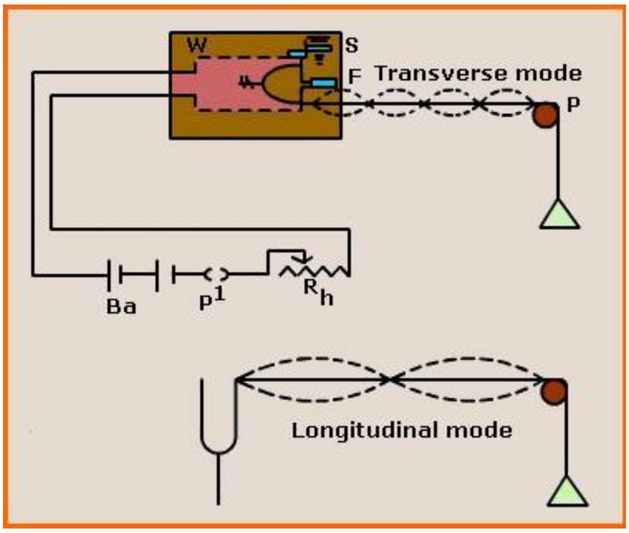
Hence, the frequency of tuning fork:

$$\eta = \frac{n}{L}\sqrt{\frac{T}{m}} \qquad \text{------------------(2)}$$

Or

$$\eta = \frac{n}{\sqrt{m}}\frac{\sqrt{T}}{L}$$

DIAGRAM:-



PROCEDURE: The apparatus (tuning fork) is first arranged for transverse vibrations, with the length of the string 3 or 4 meters & passing over the pulley. The circuit is closed vary the pot till the fork vibrates steadily. The load in the pan is adjusted slowly, till a convenient number of loops (say between 4 and 10) with well-defined nodes & maximum amplitude at the antinodes are formed, the vibrations of the string being in the vertical plane.

The number of loops (X) formed in the string between the pulley and the fork is noted. The length of the string between the pulley and the fork (d) is noted. The length (L) of a single loop is calculated by:

$$L = d / x \text{ cm}$$

Let: m = mass of the pan.

M = load added into pan.

Tension, T = (M + m)g dynes

Where g = acceleration due to gravity at the place.

The experiment is repeated by increasing or decreasing the load M, so those numbers of loops increase or decrease by one. The experiment is repeated till the whole string vibrates in one or loops & the observations are recorded.

Next the tuning fork is arranged for the longitudinal vibrations. The experiment is repeated as was done for the longitudinal vibrations & the observations are recorded.

At the end of the experiment, the mass m of the pan, the mass of the string (w) and the length (Y) of the strings are noted.

PRECAUTIONS:-

1. The loops must be well defined.
2. The plane of vibration of the thread must be vertical.

3. In counting the loops, the loops at the two extreme ends must not be taken into account.

OBSERVATIONS:-

1. Mass of the string (thread) = W = …………gm (correct to a gm)
2. Length of the (thread) string = Y =………..cm
3. Linear density of the thread = (W/Y) =………..gm/cm
4. Mass of the pan = m = …….. gm (correct to a mg)

TABULARCOLUMN:-

For Transverse arrangement:

S. No.	Load applied in to the pan M gm	Tension T= (M+m)g dynes	No. of loops "X"	Length of 'X' loops=d cm	Length of each loop L=d/x cm	$\sqrt{T}$	$\frac{\sqrt{T}}{L}$

For Longitudinal Arrangement:

S. No.	Load applied in to the pan M gm	Tension T= (M+m)g dynes	No. of loops "X"	Length of 'X' loops=d cm	Length of each loop L=d/x cm	$\sqrt{T}$	$\sqrt{T}L$

RESULT: The frequency of atuning fork in

i) Transverse arrangement = Hz

ii) Longitudinal arrangement = Hz

MODEL VIVA QUESTIONS:-

1. Define Progressive wave? What are the types of Progressive waves? Explain.
2. Define Standing waves?
3. Define nodes and anti nodes?
4. Explain the importance of Meld's experiment?
5. What is the distance between two successive nodes or two anti nodes?
6. Explain the difference between Longitudinal and Transverse waves?
7. Define Resonance condition?
8. In standing wave where the amplitude is maximum and where it is minimum?

ENGINEERING PHYSICS LAB

Experiment No. 2

DETERMINATION OF RIGIDITY MODULUS OF THE MATERIAL OF A WIRE
(Torsional pendulum)

AIM : To determine the rigidity modulus (n) of the given wire using torsional pendulum.

APPARATUS : A circular disk provided with chuck nut (Torsional pendulum), steel wire, stop watch, screw gauge, vernier calipers and meter scale.

THEORY : A torsional pendulum is a flat disk, suspended horizontally by a wire attached at the top of the fixed support.

When the disk is tuned through a small angle, the wire is twisted. On being released the disk performs torsional oscillations about the axis performs torsional oscillations about the axis of the support. The twist wire will exert a torque on the disk tending to return it to the original position. This is restoring torque. For small twist the restoring torque is found to be proportional to the amount of twist, or the displacement, so that

$$\tau = -k\theta \qquad \text{-------------------- (1)}$$

Here k is proportionality constant that depends on the properties of the wire is called torsional constant.

The minus sign shows that the torque is directly opposite to the angular displacement θ. Eqn. (1) is the condition for angular simple harmonic motion.

The equation of motion for such a system is

$$\tau = I\,\alpha = I * d^2\theta/dt^2 \qquad \text{-------------------- (2)}$$

So that, on using the equation (1) we get

$$-k\theta = I * d^2\theta/dt^2$$

$$\frac{d^2\theta}{dt^2} + \frac{k}{I}(\theta) = 0 \qquad \text{-------------------- (3)}$$

The solution of the equation 3 is, therefore, a simple harmonic oscillation in the angle co-ordinate, namely

$$\theta = \theta_m \cos(\omega t + \delta)$$

Here θ_m is the maximum angular displacement i.e. the amplitude of the angular oscillation

The period of oscillation is given by

$$T = 2\pi\sqrt{\frac{I}{K}}$$

Where, I = rotational mertia of the pendulum
k = torsional constant

If k and I are known, T can be calculated.

FORMULA:

Rigidity modulus (n) of given wire is determine using the formula

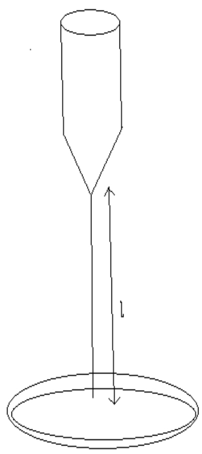
$$\eta = \frac{4\pi MR^2}{a^4}[l / T^2] \text{ dyne/cm}^2$$

PROCEDURE:

Torsional pendulum consists of a uniform circular metal (brass or iron) disc of diameter about 10 cm and thickness of 1 cm. Suspended by a metal wire (whose n is to be determined) at the center of the disc. The other end of the wire is griped in to another chuck, which is fixed to a wall bracket. The length (l) of the wire between the two chucks can be adjusted and measured using meter scale. An ink mark is made on the curved edge of the disc. A vertical pointer is kept in front of the disc such that the pointer screens the mark when straight. The disc is set in to oscillations in the horizontal plane, by tuning through a small angle. Now stopwatch is started and time (t) for 20 oscillations is noted.

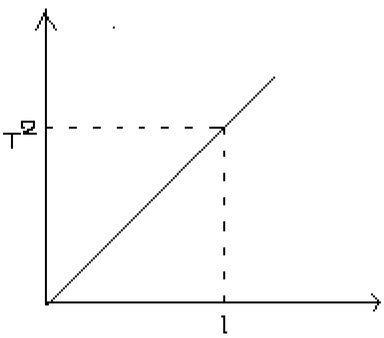
This procedure is repeated foe two times and the average value is taken. The time period T (=t/20) is calculated. The experiment is performed for five different lengths of the wire and observations are tabulated in table.

The diameter and hence the radius (a) of the wire is determined accurately at least at five different places of the wire using screw guage since the radius of the wire is small in magnitude and appears with forth power in the formula of rigidity modulus.
The mass (M) and the radius (R) of the circular disc are determine by using rough balance and vernier respectively.



MODELGRAPH:-

A graph is drawing between " l " on x-axis and T^2 on y-axis



OBSERVATION :

Mass of the disc M = gms
Radius of the disc R = cms
Radius of the wire, a = cms

TABULAR COLUMN:

S.No	MSR	VSR	L.C	MSR +	Diame	Radiu

				(VSR*LC)	ter	s(R)

S.No	PSR	HSR	L.C	PSR + (HSR*LC)	Diameter (cm)	Radius, a (cm)

S. No	Length of the wire ‘l’ between chucks (cm)	Time taken for 20 Oscillations (sec)			Time Period T (sec)	T^2	l/T^2
		Trial	Trial II	Mean			

RESULT: The Rigidity modulus of the given material of wire η =

MODEL VIVA QUESTIONS:-

1. What is Rigidity Modulus?
2. What do you mean by Torsion?
3. What are the units of the torsion constant ‘η’ in the MKS system and CGS system?
4. Define moment of inertia (I)?
5. What are the units of ‘I’ in CGS and MKS system?
6. Define time period?
7. What is the definition of torque?
8. State and explain Hook’s law?
9. How many types of modulus are there?
10. Two wires made up of the same material, one is thick and other is thin. Which wire has greater rigidity modulus? Explain.
11. What are the main differences between the simple pendulum and torsional pendulum?

ENGINEERING PHYSICS LAB

Experiment No.3

NEWTON’S RINGS

AIM : To determine the Radius of Curvature of the plano convex lens, by forming Newton's rings.

APPARATUS : A plano convex lens of know focal lenth, glass plate, sodium vapour lamp, travelling microscope, reading lens, magnifying glass and black paper.

FORMULA **:** The radius of curvature(R) of the plano convex lens is obtained from the relation:

$$R = \frac{(D_2^2 - D_1^2)}{4\,\lambda\,(n_2 - n_1)} \quad \text{--------------------} \ (1)$$

Where,

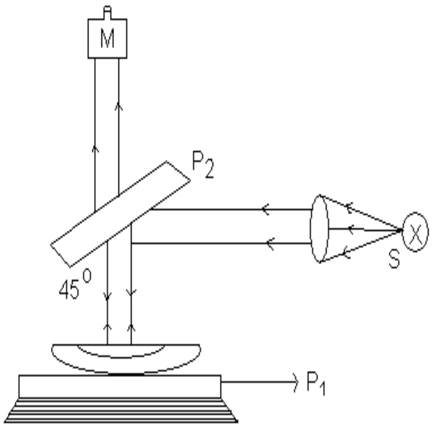
λ =Wavelength of given surface

D1 =Diameter of the **n_1th ring**

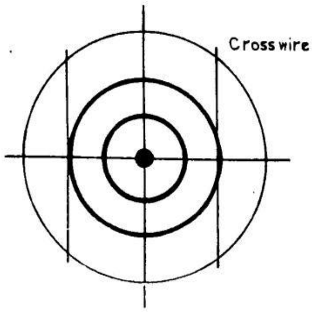
D2 = Diameter of the **n_2th ring**

The values of D1 and D2are very small and occur to the second power in equation (1). Hence they are to be measured carefully with the traveling microscope.

CIRCUIT DIAGRAM:-



Schematic Diagram of Newton's ring set up.



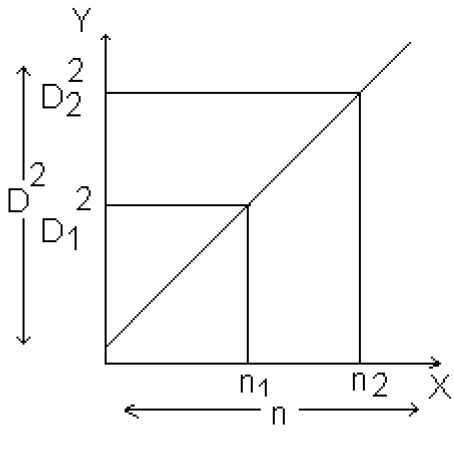
Newton's rings

PROCEDURE:

The apparatus consists of a light source. The light from it is rendered parallel by means of a convex lens. The parallel rays are incident on a plane glass plate through the magnifying glass inclinced at 45^o to the path of incident rays. Alternate bright & dark rings are observed through a traveling microscope.

The point of intersection of cross wires in the microscope is brought to the center of ring system, if necessary, tuning the cross wires such that one of them is perpendicular to the line of travel of the microscope. The wire may be set tangential to any one ring; & starting from the center of the ring system, the microscope is moved on to one side, say left, across the field of view counting the number of rings. After passing beyond 20^{th}ring, the direction of motion of the microscope is reversed and the cross wire is set at the 20^{th} dark ring, tangential to it. The reading on the microscope scale is noted. Similarly, the readings with the cross-wires set on 18^{th}, 16^{th}, 14^{th},…2^{nd} dark rings are noted. The microscope is moved in the same direction and the readings corresponding to the 2^{nd}, 4^{th}, 6^{th}… dark ring on the right side are noted. Readings are to be taken with the microscope moving in one & the same direction to avoid errors due to backlash the observations are recorded in table 1.

MODEL GRAPH: A graph is drawn with the number of rings as abscissa (X-axis) and the square of diameter of the ring as ordinate (Y-axis). The nature of the graph will be straight line as shown in the fig. From graph the values of D_1^2 and D_2^2 corresponding to two number n_1 and n_2 are noted. Using these values in equation (1) the radius of curvature R calculated.



PRECAUTIONS:-

1. Wipe the lens and glass plates with cloth before starting the experiment.
2. The centre of the ring must be dark.
3. Care is to be taken in moving the microscope to travel in a direction without moving back and forth while taking readings. This is very essential since the variation in the diameter of the rings is in the second decimal place and any back and forth movement of the microscope will result in wrong readings.
4. Use reading lens with light while observing the readings.

TABULAR COLUMN:-

S.No.of rings n	Microscope Reading		Diameter of n^{th} ring (L_1-R_1)	Square of diameter of the ring.
	Left side L_1	Right side R_1		
	MSR+(VC*LC)	MSR+(VC*LC)		

RESULT:

Radius of Curvature of the plano convex lens R =

MODEL VIVA QUESTIONS:

1. How Newton's Rings are formed?
2. Where are the interfere fringes formed?
3. Why do you get central ring dark?
4. Why we are using monochromatic source of light instead of mercury lamp?
5. Why Newton's rings are circular?
6. What is the use of interference phenomenon?
7. Without using light can you demonstrate interference effect?
8. What are the uses of Newton's rings?
9. What is constructive interference and destructive interference?

ENGINEERING PHYSICS LAB

Experiment No. 4

DIFFRACTION GRATING – NORMAL INCIDENCE & MINIMUM DEVATION

AIM : To determine the wavelength of a given light radiation using plane transmission grating in the normal incidence method.

APPARATUS : Spectrometer,Source oflight(Mercury lamp (or) Sodium vapour lamp), Transmission Grating,magnifying lens and spirit level.

DESCRIPTION : A plane diffraction grating consists of a parallel – sided glass plate with equidistant parallel lines drawn very closely on it by means of a diamond point 15,000 lines per inch or (15,000/2.54) lines per cm are drawn on the grating. Such gratings are known as original gratings. But the gratings used in the fixed over as optically plane glass plane. Care should be taken while handling the grating. It should be handled by the edge of the plate.

THEORY : A parallel beam of monochromatic light from the collimator of a spectrometer is made to fall normally on a plane diffraction grating erected vertically on the prism table .The telescope initially in line with the collimator is slowly turned to one side .A line spectrum will be noticed and on further turning the telescope the line spectrum will again be noticed. While the former is called the first order spectrum, the later is called the second order spectrum .On further rotating the telescope .the third order spectrum may also be noticed, depending on the quality of the grating. But the number of orders of spectra that can be observed with a grating limited. With the light normally incident on a grating having N lines per cm. if θ is the angle of diffraction of a radiation of wavelength λ in the nth order spectrum then

$$n \lambda N = \text{Sin } \theta$$

or

$$\lambda = \frac{\text{Sin } \theta}{\mathbf{nN}}$$

or

$$\boldsymbol{\lambda} = \frac{\textbf{Sin } \boldsymbol{\theta} \textbf{ x 2.54}}{\textbf{n x 15,000}} \quad \text{--------------------} \ \mathbf{(1)}$$

Knowing θand n, the wavelength of light radiation is calculated using equation (1) for the normal incidence method.

PROCEDURE:

Normal incidence method: - preliminary adjustments of the spectrometer are made. Focussing and adjusting the eye piece of the telescope to a distant object. The grating table is leveled with a spirit level .The grating is mounted on the grating table for the normal incidence .The slit of collimator is illuminated with sodium light.

The direct reading is taken the telescope is turned from the position through 90^o and fixed in this position, as shown in the fig -1.

The grating is mounted vertically on the grating plotform the rulings on it being parallel to the slit in the collimator. The plotform is now rotated until the image of the slit as reflected by the glass surface is seen in the telescope. The vertically cross wire is made to coincide with the fixed edge of the image .The plotform is fixed in this position. The vernier table is now rotated in the appropriate direction through 45^o so that the rays of light from the collimator fall normally, on the grating

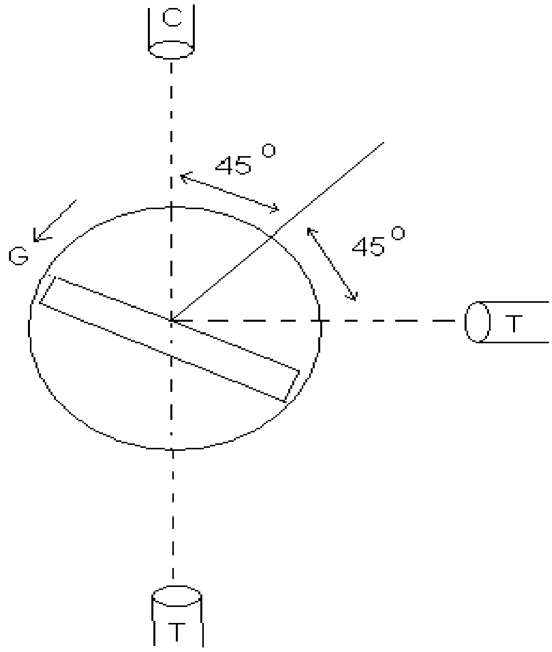


Figure-1. Grating set for normal incident light

The telescope is now released and rotated it so as to catch the first order – diffracted image on one side, say right (or left) as shown in the fig 2.with sodium light two images of the slit, very close to each other are seen. These are the D and D lines of sodium light .The point of intersection of the cross wires is set on the D line and the reading in the vernier I &II is noted. Similarly, the reading corresponding to the D line is noted .the telescope is now focused to the direct ray passing through the grating and the point of intersection of the crosswire is set on the direct ray .The reading in the vernier I &II is noted. The difference in the readings corresponding to any one gives the angle of diffraction θ for that line in the first order spectrum.

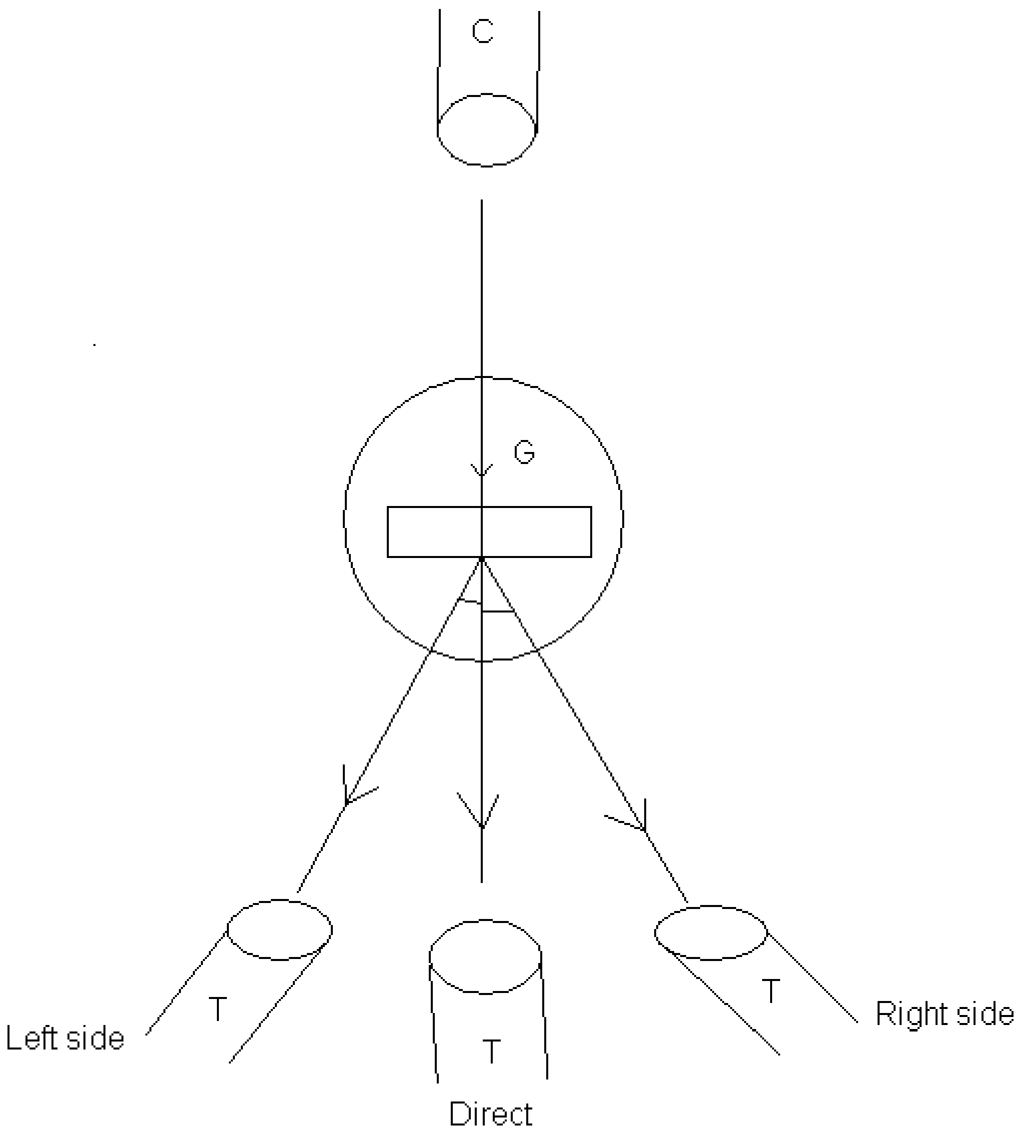


Figure-2.Diffracted image

OBSERVATION:

1.The valu of the main scale division, S=

2.The number of divisions on the vernier, N=

3.The least count of the vernier, LC=S/N=

ENGINEERING PHYSICS LAB

Experiment No.5

DISPERSIVEPOWEROFPRISM
{Spectrometer method}

AIM : To determine the dispersive power of the material of the given prism by the spectrometer.

APPARATUS : Spectrometer,Mercury Vapour Lamp, Prism, Magnifying lens and Spirit level.

THEORY : The essential parts of the spectrometer are:(a) The telescope, (b)The collimator & (c) prism table.

(a) The Telescope:-

The telescope is an astronomical type .At one end of a brass tube is an objective, at the other end a (Rams den's) eye piece and in between, a cross wire screen .The eye piece may be focused on the cross –wires and the length of the telescope may be adjusted by means of a rack and pinion screw .The telescope is attached to a circular disc,which rotates symmetrically about a vertical axis and carries a main scale, divided in half – degrees along its edges. The telescope may be fixed in any desired position by means of a screw &fine adjustments made by a tangential screw

(b)The Collimator:-

The collimator consists of a convex lens fitted at one end of a brass tube and an adjustable slit at the other end. The distance between the two may be adjusted by means of a rack and pinion screw .The collimator is rigidly attached to the base of the instrument.

(c) The prism Table:-

The prism table consists of a two circular brass discs with three leveling screws between them. A short vertical brass rod is attached to the center of the lower disc & this is fitted into a tube attached to another circular disc moving above the main scale. The prism table may be fixed on the tube by means of a screw. The second circular disc moving over the main scale carries two verniers at diametrically opposite. The vernier disc also revolves about the vertical axis passing through the center of the main scale and may be fixed in any position with the help of a screw .A tangential screw is provided for fine movements of the vernier scale. Most Spectrometers have 29 main scale divisions (half –degrees) divided on the vernier into thirty equal parts .Hence, the least count of the vernier is one – sixteenth of a degree or one minute.

Preliminary Adjustments:

The following adjustments are to be made before the commencement of an experiment with spectrometer.

(I) Eyepiece Adjustment: -

The telescope is turned towards a bright object, say a white wall about 2 to 3 meters way and the eyepiece is adjusted so that cross - wires are very clearly seen. This ensures that whenever an image is clearly seen on the cross – wires, the eye is an unstrained condition.

(II) Telescope Adjustment: -

The telescope is now turned towards a bright object, and its length is adjusted until the distant objects are clearly seen in the plane of the cross – wires: that is the image suffers no lateral displacement, with the cross – wire of the eye shifted slightly to and fro. In this position the telescope is capable of receiving parallel rays. This means that whenever any image is seen clearly on the cross – wires, it may be taken that the rays entering the telescope constitute a parallel bundle.

In case the experiment is to be performed in a dark room from which a view of distant object is difficult to obtain, the method suggested by Schewster may be adopted.

A prism is placed on the prism table and a refracted image of the slit is viewed .The prism is adjusted to be almost at minimum deviation .At this stage, it will be found that the image is fixed telescope for two positions of the prism ,which may be obtained by turning the prism table one way or other. The prism table alone is adjusted so that the image leaves the field of vision (traveling towards the direct ray) and returns again. Now the collimator alone is adjusted for clarity of image. This is repeated a few times until the image is quite clear.

(III) Collimator adjustment: -

The slit of collimator is illuminated with light. The telescope is turned to view the image of the slit and the collimator screws are adjusted such that a clear image of the slit is obtained without parallax in the plane of the cross – wires. The slit of the collimator is also adjusted to the vertical & narrow.

The refractive index of the material of the prism is given by

$$\boxed{\mu = \frac{\mathbf{Sin}\frac{A+D}{2}}{\mathbf{Sin(A/2)}} \text{ -------------------- } (1)}$$

Where, A is the angle of the equilateral prism and D is the angle of minimum deviation

When the angle of incidence is small, the angle of deviation is large .As the angle incidence is slowly increased, the angle of deviation begins to diminish progressively, till for one particular value of the angle of incidence, the angle of deviation attains a least value. This angle is known as the angle of minimum deviation D.

The dispersive power (**ω**) of thematerial of the prism is given by

$$\omega = \frac{\mu_1 - \mu_2}{(\mu - 1)} \qquad \text{-------------------- (2)}$$

Where,

μ_1 = the refractive index of the one ray

μ_2 = the refractive index of the another ray and

$$\mu = \frac{(\mu_1 + \mu_2)}{2}$$; the mean of μ_B and μ_R

Noting the angle of minimum deviation D. for blue & red rays μ_B and μ_R are calculated using equation (1) and using equation (2) the dispersive power of the material of the prism is calculated.

<u>PROCEDURE</u>:

The prism is placed on the prism table with the ground surface of the prism on to the left or right side of the collimator. Care is to be taken to see that the ground surface of the prism does not face either the collimator or the telescope. The vernier table is then fixed with the help of vernier screw.

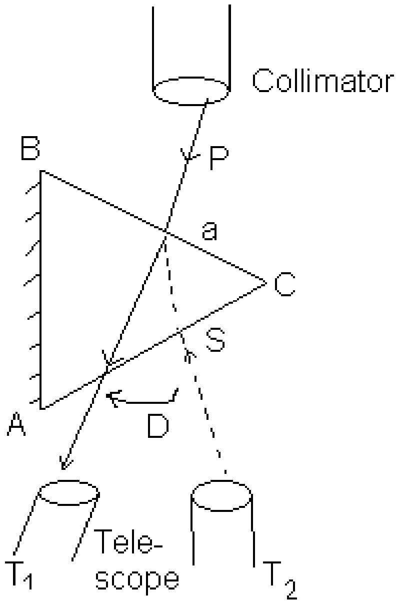
The ray of light passing through the collimator strikes the polished surface BC of the prism at Q and undergoes deviation along QR and emerges out of the prism from the face AC. The deviated ray (continuous spectrum) is seen through the telescope in position T2. Looking at the spectrum the prism table is now slowly moved on to the one side, so that the spectrum moves towards undeviated path of the beam. The deviated ray (spectrum) also moves on to the same side for some time and then the ray starts turning back even though the prism table is moved in the same direction. The point at which the ray starts turning back is called minimum deviation position. In the spectrum, it is sufficient if one colour is adjusted for minimum deviation position. In this limiting position of the spectrum, deviation is minimum.

Now the telescope is fixed on the required colour and the tangent screw is slowly operated until the point of intersection of the cross wire is exactly on the image. The reading for that colour is noted in vernier I and vernier II and tabulated. The telescope is now moved on the another colour and the readings are taken as explained for first colour (This readings=A).

Next, the telescope is released and the prism is removed from the prism table. The telescope is now focused on to the direct ray (undeviated path) and the reading in vernier I and vernier II are noted (This reading=B). The value (A-B) will give the angle of minimum deviation.

The refractive indices for the blue and red rays are calculated using equation-(1) (Assuming the angle of the equilateral prism, A = 60^0, the values of μ_1 and μ_2 are substituted in equation (2) and the dispersive power of the material of the prism is calculated.

DIAGRAM:-



Arrangement of prism for dispersive power

PRECAUTIONS:-

1. Do not touch the polished surface of the prism with hands to avoid finger prints.
2. Use reading lens with light while taking the readings in vernier scale.
3. The mercury light should be placed inside a wooden box.

TABULAR COLUMN:-

Vernier	MSR	VC	B=MSR+(VC*LC)
V1			
V2			

Colour	Vernier	A= MSR+(VC*LC)	D=A-B	Dmin=(D1+D2)/2
	V1		D1=	
	V2		D2=	

RESULT: Dispersive power of the material of the given prism ω =

MODEL VIVA QUESTIONS:

1. What is Dispersion?
2. What is dispersive power?
3. What is minimum deviation?
4. What is angular dispersion?
5. In the VIBGYOR which colour is having more wavelength and which colour is having less wavelength?
6. In the VIBGYOR which colour is having more frequency and which colour is having lessfrequency?
7. What type of light do used in dispersive power experiment?
8. If you replace mercury light with sodium vapour lamp in the present experiment what colours do you observe in the spectrum?
9. What are the units of wavelength in S.I units?
10. Why the telescope and collimator adjusted for parallel rays?
11. What type of eye piece is used in spectrometer?
12. What are the advantages and disadvantages of Rams den’s eye piece?

TABULAR COLUMN:

Order of spectrum	Colour of line	Vernier	Telescope reading		Angle of diffraction $2\theta=L-R$	Avg.of diffraction $\theta=(\theta_1+\theta_2)/4$	$\lambda = \sin\theta/Nn$
			Left side	Right side			
			MSR+(VC*LC)	MSR+(VC*LC)			
n=1		V1			$2\,\theta_1=$	$\theta =$	
		V2			$2\,\theta_1=$		

RESULT : Wavelength of a given light radiation using plane transmission grating in the normal incidence method $\lambda =$

MODEL VIVA QUESTIONS:

1. What is Diffraction?
2. What is Diffraction Grating?
3. What are the types of grating?
4. What is reflection grating?
5. What are the requisites of good grating?
6. What are the conditions for diffraction of light?
7. Diffraction is the special kind of interference. Explain why?
8. What is the principle section?
9. What is the optic axis?
10. What are the essential parts of a spectrometer?

ENGINEERING PHYSICS LAB

Experiment No.6

Coupled Oscillator

Apparatus:

Two compound pendulums, coupling spring, convergent lens, filament bulb on stand, screen on stand, stop clock.

Purpose of experiment:

To study normal modes of oscillation of two coupled pendulums and to measure the normal mode frequencies.

Basic methodology:

Two identical compound pendulums are coupled by means of a spring. Normal mode oscillations are excited and their frequencies are measured.

Introduction

The reason why the study of simple harmonic motion is important is the very general manner in which such a motion arises when we want the response of a system to small deviations from the equilibrium configuration. This happens for a wide variety of systems in Physics and Engineering.

The response of a system to small deformations can usually be described in terms of individual oscillators making up the system. However, the oscillators will not have independent motion but are generally coupled to other oscillators. Think for example of vibrations in a solid. A solid can be thought of as being composed of a lattice of atoms connected to each other by springs. The motion of each individual atom is coupled to that of its neighbouring atoms.

The description of a system of coupled oscillators can be done in terms of its **normal modes**. In a coupled system the individual oscillators may have different natural frequencies. A normal mode motion of the system however will be one in which all the individual oscillators oscillate with the same frequency (called the normal mode frequency) and with definite phase relations between the individual motions. If a system has *n* degrees of freedom (i.e. has *n* coupled oscillators) then there will be n normal modes of the system. A general disturbance of the system can be described in terms of a superposition of normal mode vibrations. If a single oscillator is excited, then eventually the energy gets transferred to all the modes.

In this experiment we will study some of the above features in the simple case of two coupled compound pendulums. The system studied in the experiment consists of two identical rigid pendulums, *A* and *B*. A linear spring couples the oscillations of the two pendulums. A schematic diagram of the system is given in Figure 1.

The motion of the two pendulums *A* and *B* can be modeled by the following coupled differential equations (θ_A and θ_B are the angular displacements of *A* and *B*, *I* their moments of inertia)

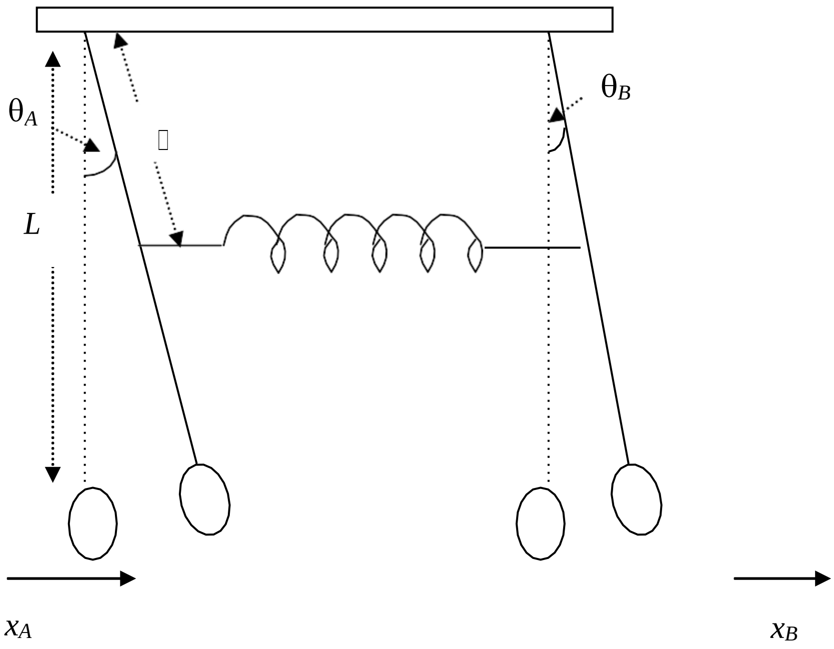


Fig.1

The equations of motion of the two physical pendulums are easily obtained. Let θ_A and θ_B be the angular displacements, and x_A and x_B the linear displacements of the two pendulums respectively. The compression of the spring will be $(x_A - x_B)\frac{l}{L}$ where l is the distance between the point of suspension and the point where the spring is attached and L the length of the pendulum. The rotational equation for pendulum. A will thus be

$$I\frac{d^2\theta_A}{dt^2} = -mgL_{CM}\sin\theta_A - k(x_A - x_B)\frac{l}{L}l\cos\theta_A, \qquad (1)$$

where, the first term on the right is the restoring torque due to gravity (L_{CM} being the distance between the point of suspension and the position of the center of mass of pendulum A) while the second term that due to the spring force. Assuming the mass attached to pendulum A to be sufficiently heavy we can equate L_{CM} and L. We also consider small displacements θ_A, so that $\sin\theta_A \approx \theta_A$ and $\cos\theta_A \approx 1$. Substituting $\theta_A = x_A/L$ and using the above approximations, we obtain the following equation of motion for the linear displacement x_A:

$$\frac{d^2x_A}{dt^2} = -\left(\frac{mgL}{I}\right)x_A - k(x_A - x_B)\frac{l^2}{I} \qquad (2)$$

Likewise the equation for x_B is

$$\frac{d^2x_B}{dt^2} = -\left(\frac{mgL}{I}\right)x_B + k(x_A - x_B)\frac{l^2}{I} \qquad (3)$$

Equations (2) and (3) are **coupled**, i.e. the equation for x_A involves x_B and vice-versa.Without the coupling, i.e. in the absence of the spring, x_A and x_B would be independent oscillations with the natural frequency $\omega_0^2 = \sqrt{\frac{mgL}{I}}$.

It is easy to find uncoupled equations describing the normal modes of the system. Define the variables

$$x_1 = x_A + x_B \quad ; \quad x_2 = x_A - x_B \tag{4}$$

Adding and subtracting eqs. (2) and (3) we obtain equations for the variables x_1 and x_2 as

$$\frac{d^2x_1}{dt^2} = -\left(\frac{mgL}{I}\right)x_1 \tag{5}$$

$$\frac{d^2x_2}{dt^2} = -\left(\frac{mgL}{I}\right)x_2 - 2\frac{k\ell^2}{I}x_2 \tag{6}$$

Note that the equations for x_1 and x_2 are uncoupled. The variables x_1 and x_2 describe independent oscillations and are the two normal modes of the system. The general solution to these equations will be

$$x_1(t) = A_1 \cos(\omega_1 t + \varphi_1) \quad ; \quad x_2(t) = A_2 \cos(\omega_2 t + \varphi_2) \tag{7}$$

(A_1, A_2 being the amplitudes of the two modes and φ_1, φ_2 arbitrary phases). The corresponding natural frequencies are the normal mode frequencies:

$$\omega_1 = \omega_0 \quad ; \quad \omega_2 = \sqrt{\omega_0^2 + \frac{2k\ell^2}{I}} = \omega_0\sqrt{1 + \frac{2k\ell^2}{mgL}} \tag{8}$$

where $\omega_0 = \sqrt{\frac{mgL}{I}}$ is the natural frequency of each uncoupled pendulum.

It is instructive to visualize the motion of the coupled system in these normal modes. If we excite only the first normal mode, i.e. $x_1(t)\neq 0$, but $x_2(t)=0$ at all times, the individual motions of pendulums *A* and *B* will be

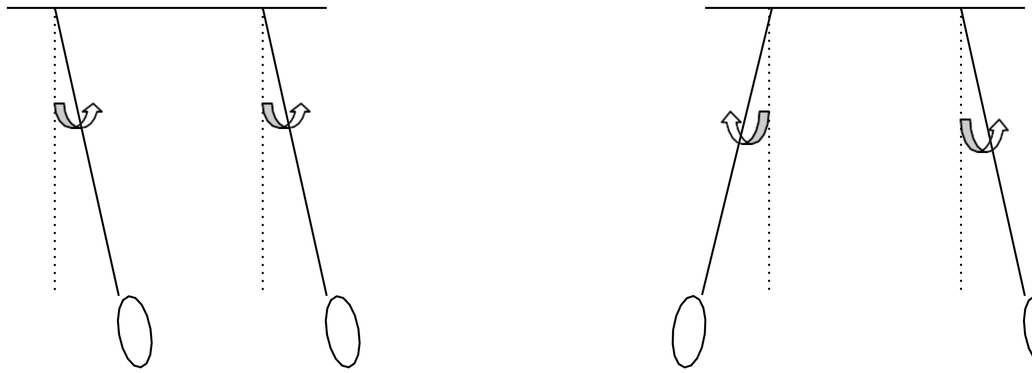
$$x_A(t) = \frac{1}{2}\left(x_1(t) + x_2(t)\right) = \frac{A_1}{2}\cos\left(\omega_1 t + \varphi_1\right) = x_B(t) = \frac{1}{2}\left(x_1(t) - x_2(t)\right) \tag{9}$$

Note that in this mode $x_A = x_B$. This describes a motion in which both pendulumsmove in phase with the same displacement and with frequency ω_1.

On the other hand if the second mode is excited, i.e. $x_1(t)=0$ for all times and $x_2(t)\neq 0$the individual motions are

$$x_A(t) = \frac{1}{2}\left(x_1(t) + x_2(t)\right) = \frac{A_2}{2}\cos\left(\omega_2 t + \varphi_2\right) = -x_B(t) = \frac{-1}{2}\left(x_1(t) - x_2(t)\right) \tag{10}$$

In this mode the displacements of the pendulums are always opposite ($x_A(t)=-x_B(t)$). Their motions have the same amplitude and frequency ($=\omega_2$) but with a relative phase difference of π. Figure 2 shows the motions in the normal modes.



1st normal mode 2nd normal mode

Fig.2

A general motion of the coupled pendulums will be a superposition of the motions ofthe two normal modes:

$$x_A(t) = \frac{1}{2}\left[A_1 \cos(\omega_1 t + \varphi_1) + A_2 \cos(\omega_2 t + \varphi_2)\right]$$

$$x_B(t) = \frac{1}{2}\left[A_1 \cos(\omega_1 t + \varphi_1) - A_2 \cos(\omega_2 t + \varphi_2)\right] \quad (11)$$

For a given initial condition the unknown constants (two amplitudes and two phases) can be solved. Consider the case where the pendulum A is lifted to a displacement *A* at $t = 0$ and released from rest while *B* remains at its equilibrium position at $t = 0$. The constants can be solved (see Exercise 4) to give the subsequent motions of thependulums to be

$$x_A(t) = A\cos\left(\frac{\omega_2 - \omega_1}{2} t\right)\cos\left(\frac{\omega_2 + \omega_1}{2} t\right)$$

$$x_B(t) = A\sin\left(\frac{\omega_2 - \omega_1}{2} t\right)\sin\left(\frac{\omega_2 + \omega_1}{2} t\right) \quad (12)$$

The motions of the pendulums *A* and *B* exhibit a typical beat phenomenon. The motion can be understood as oscillations with a time period $4\pi/(\omega_2 + \omega_1)$ and a sinusoidally varying amplitude $A(t) = A\cos(\frac{\omega_2 - \omega_1}{2} t)$ with the amplitude becoming zero with a period of $2\pi/(\omega_2 - \omega_1)$. As an example, Figure 3(a), 3(b) show plots of $x(t) = \sin(2\pi t)\sin(50\pi t)$ and $x(t)=\cos(2\pi t)\cos(50\pi t)$ vs. t respectively.

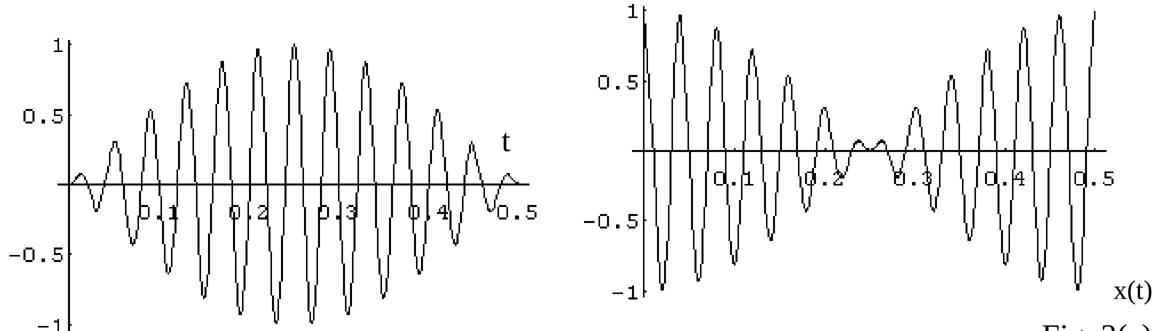


Fig. 3(a)

Observations&Calculations

Leastcountofthestopwatch:

Before Coupling: Spring 1

Time period of pendulum 1 :

Time period of pendulum 2

Before Coupling : Spring 2

Time period of pendulum 1

Time period of pendulum 2

AfterCoupling

Sl. No		Measured ValuesofTime Period				Calculated Values		
		InPhasemode (sec)	OutofPhasemode (sec)	Coupledmode (sec)	Beats (sec)	$T_c = \frac{2T_0T_1}{T_0+T_1}$ (sec)	$T_B = \frac{2T_0T_1}{T_0-T_1}$ (sec)	**Degreeof Coupling** $\chi = \frac{T_0^2-T_1^2}{T_0^2+T_1^2}$
1	Spring1	$T_0=$ 1. 2. 3. Av.$T_0=$	$T_1=$ 1. 2. 3. Av.$T_1=$	$T_c=$ 1. 2. 3. Av.$T_c=$	$T_B=$ 1. 2. 3. Av.$T_B=$			
2	Spring2	$T_0=$ 1. 2. 3. Av.$T_0=$	$T_1=$ 1. 2. 3. Av.$T_1=$	$T_c=$ 1. 2. 3. Av.$T_c=$	$T_B=$ 1. 2. 3. Av.$T_B=$			

Results:

Spring 1

1) Calculated T_c= whereas measured T_c=

2) Calculated T_B= while measured T_B=

3) Degree of coupling χ=

Spring 2

1) Calculated T_c= whereas measured T_c=

2) Calculated T_B= while measured T_B=

3) Degree of coupling χ=

Set-up and Procedure

1. Uncouple the pendulums. Set small oscillations of both pendulums individually. Note the time for 20 oscillations and hence obtain the average time period for free oscillations of the pendulums and the natural frequency ω_0.
2. Couple the pendulums by hooking the spring at some position to the vertical rods of the pendulums. Ensure that the spring is horizontal and is neither extended nor hanging loose to begin with.
3. Switch on the bulb and observe the spot at the centre of the screen.
4. Excite the first normal mode by displacing both pendulums by the same amount in the same direction. Release both pendulums from rest. The spot on the screen should oscillate in the horizontal direction.
5. Note down the time for 20 oscillations and hence infer the time period T_1 and frequency ω_1 of the first normal mode.
6. With the spring at the same position excite the second normal mode of oscillation by displacing both pendulums in the opposite directions by the same amount and then releasing them from rest.
7. The spot on the screen should oscillate in the vertical direction. Note down the time for 20 oscillations and hence infer the time period T_2 and frequency ω_2.
8. Repeat these measurements for the spring hooked at 3 more positions on the vertical rods of the pendulums.

(Part B)

9. For any one position of the spring (already chosen in Part A), now displace any one pendulum by a small amount and (with the other pendulum at its equilibrium position) release it from rest. Observe the subsequent motion of the pendulums. Try to qualitatively correlate the motion with the graph shown in Fig. 3. Measure the time period T of ***individual*** oscillations of the pendulum A and also the time period ΔT between the times when A comes to a total stop. Repeat these measurements three times for accuracy. Infer the time periods T_1 and T_2 of the normal modes from T and ΔT and compare with earlier results.

(Note: Your measurements will be more accurate only if you choose l somewhat smaller than the total length L, i.e. choose a position of the coupling spring which is intermediate in position).

Exercises and Viva Questions

1. What are the normal mode oscillations of a system? How many normal modes will a system posses?
2. Infer the normal mode frequencies for the coupled pendulum by directly considering the motion in the two modes as shown in Figure 2.
3. Qualitatively explain why the first normal mode frequency is independent of the position of the spring while the second normal mode frequency increases with l, the distance of the spring from the point of support.

4. For the case where pendulum A is lifted and released from rest derive the unknown constants A_1, A_2, φ_1, φ_2 in equation (11) to obtain the solution equation (12).
5. Explain the effect of damping on the motion. Redraw Figure 3 qualitatively if damping is present.
6. List all the approximations made in the theory of the double pendulum treated in the theory as against the actual apparatus used and estimate the errorintroduced. Also, consider possible sources of random errors while conductingthe experiment.
7. Explain why the spot on the screen moves the way it does, i.e., horizontally when the 1st normal mode is excited and vertically when the 2nd normal mode is excited.
8. Describe and explain the motion of the spot on the screen when only one pendulum is displaced.
9. In Part B, derive the expressions for the normal modes ω_1 and ω_2 from the T and ΔT. What is the reason that the procedure asks you to choose a value of l small compared to L for better accuracy?
10. Give some more examples of coupled oscillations from Physics or Engineering systems.

ENGINEERING PHYSICS LAB

Experiment No.7

L.C.R. CIRCUIT

AIM : The aim of this experiment is to study the characteristics of LCR series circuit and to determine 1.Resonant frequency, 2.Quality factor and 3.Band width.

APPARATUS : L.C.R. circuit board with a set of inductor(s), capacitor(s) and resistor(s), an ammeter; signal generator and connecting wires etc.

THEORY & PRINCIPLE:

When an alternating e.m.f. of frequency, **f** is applied to a circuit having an inductor(L), capacitor(C) and a resistor(R) in series as shown in Figure-2 the maximum value of a.c.current flowing in the circuit is given by

$$I_0 = \frac{E_0}{\sqrt{R^2 + (X_L - X_C)^2}} \text{ -------------------- (1)}$$

Where,

E_o = maximum value of applied e.m.f.

R = resistance applied

$X_L = \omega L$ =inductive reactance i.e. effective resistance offered by inductor in an a.c. circuit.

$X_c = 1/\omega C$ = capacitive reactance i.e. effective resistance offered by a capacitor in an a.c. circuit;

Hence,

$$I_0 = \frac{E_0}{\sqrt{R^2 + (X_L - X_C)^2}}$$

plays the same role in the a.c. circuit as a resistance in d.c. circuit. This is known as impedance, Z of the circuit. Thus,

$$Z = \sqrt{R^2 + (X_L - X_C)^2} \text{ -------------------- (2)}$$

1. Resonant frequency:

From eq.2 it is obvious that for a given L and C inductive and capacitive reactance's depends on the frequency of applied e.m.f.$X_L$increases as frequency increases where as X_c decreases and at a particular frequency both become equal. Hence, the effective reactance **(**$X_L - X_c$**)** in the circuit becomes zero, and the resultant impedance of the circuit is a minimum (=R). The particular frequency at which impedance of a series L-C-R circuit becomes minimum or the current becomes maximum is called the **resonant frequency(f_o)** and the circuit is called **series resonant circuit.**

Expression for f_o:

At resonant frequency, f_o we know

$$f_0 = \frac{1}{2\pi\sqrt{LC}} \text{ -------------------- } (3)$$

Eq. (3) shows that the resonant frequency depends on the values of L and C but does not on R.

Following figure shows the variation of the peak value of current with frequency of applied a.c. e.m.f. for different resistances

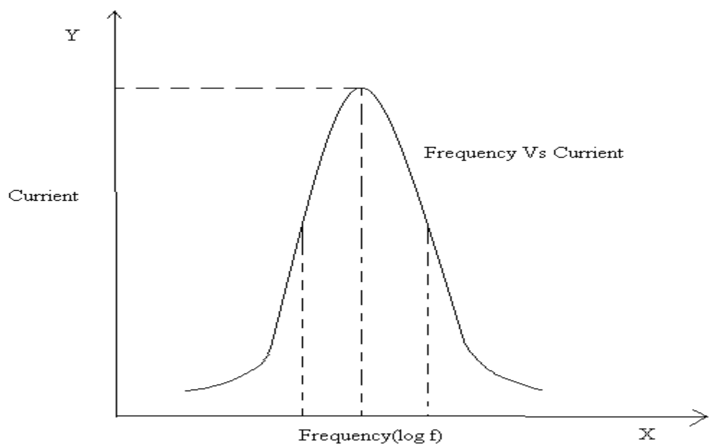


Figure-1

The curves are plotted at three different resistances R, R', R" (R<R'<R"). From the Figure-3 following observations can be made:

1. In the beginning the current increases slowly, then sharply to a maximum as frequency increases to resonant frequency (f_o), and finally decreases.
2. Resonant frequency (f_o) is independent of resistance of the circuit.
3. Peak of the curve depends on the resistance of the circuit. However, higher the R, higher the peak and vice versa. The peak is known as sharpness of the resonance. Therefore the R sharper is resonance.

2. Quality factor:

The **Quality factor** is a measure of the efficiency of stored in an inductor or a capacitor

When, an alternating current is applied.

It is defined as 2π times the ratio of energy stored to the average energy loss per period.

i.e.

Q = 2 π (energy stored)/ (energy loss per period).

Or

Q = 2 π f_0(energy stored)/ (power loss per period)

Expression for Q:

At the instant of maximum current Io, through the inductor, the energy stored

$$= \frac{1}{\sqrt{2}} LI_0$$

and the power loss per period

$$= \frac{1}{\sqrt{2}} L_0^2R$$

$$\mathbf{Q = 2\pi f_o L/R = \omega_L/R = X_L/R}$$

Similarly, it can be shown that

$\mathbf{Q = 1/\omega_C R = X_c/R}$

Hence, Quality factor can also be defined as the ratio of reactance of either inductance or capacitance. Since at the resonant frequency both reactances are equal, **Q** will remain same.

3. Band width:

The difference of two half power frequencies is called as **Band Width** of a resonant curve.

Band Width (B.W.) = f_2-f_1= f_0/ Q = f_0R/ ω_L = R/2πL

The half power frequencies **(**f_1 and f_2**)** corresponding to the frequencies at which instantaneous current becomes $1/\sqrt{2}$ **or 0.707** times its maximum value (I_0).

PROCEDURE:

(1) Make the necessary connections as shown in Figure-2 See the voltage of 10V is applied.

(2) Calculate the frequency for the given L&C to set required frequency range at the signal generator.

(3). Vary the frequency in equal steps till the ammeter record a sharp rise and fall, adjust the signal such that the ammeter deflection is maximum possible. This is the resonant frequency of the connected combination of the circuit. And note down the readings in table.1.

(4) Adjust the signal generator amplitude such that to get full scale deflection. Now reduce the frequency till the deflection falls considerably, by increasing the frequency in regular intervals and note down the ammeter readings.

(5) Repeat the above steps second time and find the average.

(6) Find the resonant frequency from the graph, this value should be close to the calculated value.

(7) Repeat above steps using different combinations of R's to study how f_o, Q, B.W. are affected.

Series Resonant Circuit:

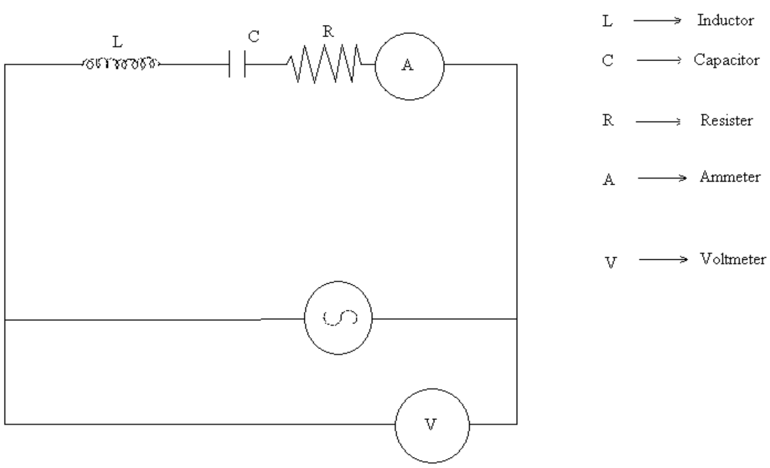


Figure-2

Parallel Resonant Circuit:

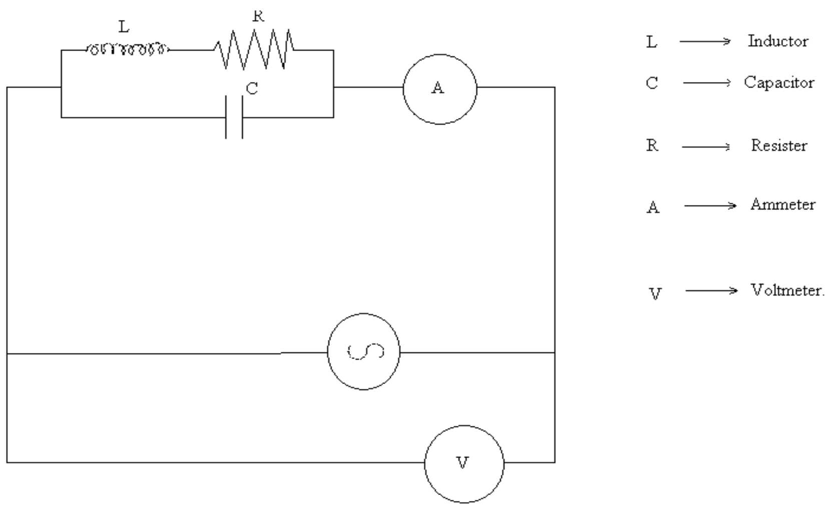


Figure-3

OBSERVATIONS:-

Table-1

S.No	**Applied frequency ( )**	**Deflection of Ammeter ( )**								
		R1( )			**R2 ( )**			**R3( )**		
		Trail 1	Trail 2	Avg.	Trail 1	Trail 2	Avg.	Trail 1	Trail 2	Avg.

CALCULATIONS:-

1. Resonant frequency (f_o):

a. Theoretical:

b. Experimental:

2. Quality factor (Q):

3. Band Width (B.W.):

RESULT: Resonant frequency, quality factor and bandwidth are calculated for various combinations of L, C and R. The results are tabulated (table.2)

Table-2.

L = ; C =

Resistance (R) ( )	Peak current (I_o) ( )	Resonant freq. (f_o) ( )	Q factor (Q) ( )	Band Width (B.W) ( )

From the values tabulated following conclusions can be drawn:

1. Resonant frequency, band widths are independent of resistances used where asQ – Factor and peak value of current does.
2. Q – factor and peak current decreases as R increases.
3. Lower R, Sharper is resonance.

MODEL VIVA QUESTIONS:-

1. Parallel resonance circuit is rejecter circuit and series resonance circuit is an acceptor circuit. Explain why?
2. Explain the importance of the band width.
3. What happens when we tune radio or T.V?
4. Why does the series circuit gave a power maximum at resonance while the parallel circuit lead to a power minimum?
5. What is the role of the inductance in LCR circuit? What are the units of inductance?

ENGINEERING PHYSICS LAB

Experiment No.8

CHARACTERISTICS OF LASER DIODES

AIM:

To study the Optical Power **(Po)** of a Laser Diode vs Laser Diode Forward Current (**I_F**)

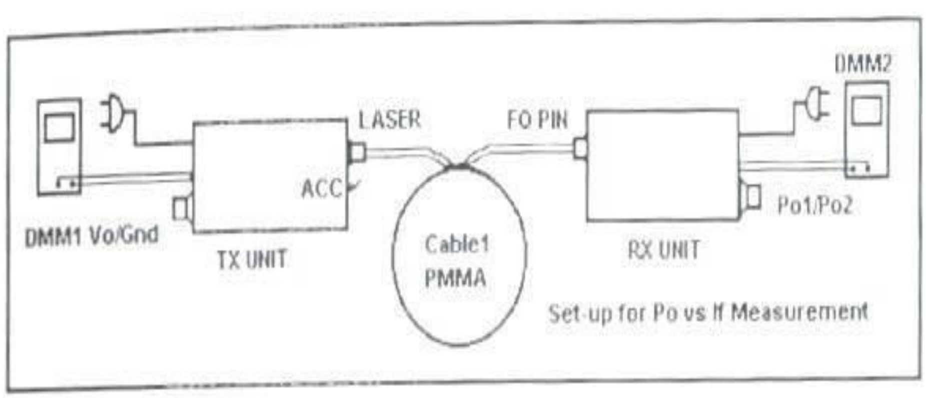
APPARATUS:

(1.) Laser Diode Design Module TNS 20EL-TX **(**2.) Laser Diode Design Module TNS 20EA-RX (3.) Two meter PMMA fiber patch card **(**4.) Inline SMA adaptors

THEORY:

Laser Diodes (LDs) are used in telecom, data communication and video communication applications involving high speeds and long hauls. Most single mode optical fiber communication systems use lasers in the 1300nm and 1550 nm windows. Lasers with very small line-widths also facilitate realization of wavelength division multiplexing (WDM) for high density communication over a single fiber. The inherent properties of LDs that make them suitable for such applications are, high coupled optical power into the fiber (greater than 1 mw), high stability of optical intensity, small line- widths (less than 0.05 nm in special devices), high speed (several GHz) and high linearity (over a specified region suitable for analogue transmission). Special lasers also provide for regeneration/amplification of optical signals within an optical fiber. These fibers are known as erbium doped fiber amplifiers. LDs for communication applications are commonly available in the wavelength regions 650nm, 780nm, 850nm, 980nm, 1300nm and 1550nm.

BLOCKDIAGRAM



PROCEDURE:

The schematic diagram for study of the LD Po as a function of LD forward current IF is shown below and is self explanatory.

1. Connect the 2-metre PMMA FO cable (Cab1) to TX Unit of TNS20EL and couple the laser beam to the power meter on the RX Unit as shown. Select ACC Mode ofoperation.
2. Set DMM 1 to the 200 mV range and connect it to the **Vo/Gnd terminals.** This will monitor **if in ma**, given by **VO (mV)/100**. Set DMM2 to 2000 mV range and connect it to the **Po1/Po2 terminals**. This will provide Po in dBm when divided by10.
3. Adjust the **SET Po** knob to extreme counterclockwise position to reduce IF to 0 ma. The power meter reading will normally be below – 50 dBm or outside the measuring limits of the powermeter.
4. Slowly turn the **SET Po** Knob clockwise to increase IF and thus Po. Note IF and Po readings. Take closer readings prior to and above the laser threshold. Current, Po will rapidly increase with small increase inIF.

OBSERVATIONS (ACC Mode/PMMA Cable)

Sl No	Vo(mV)	IF=Vo/100(ma)	Po (dBm)
1			
2			
3			
4			

RESULT:

Studied the Optical Power **(Po)** of a Laser Diode vs Laser Diode Forward Current ($\mathbf{I}_F$) Characteristics

Viva –voce:

1. What is laser?
2. What is the difference between ordinary light and laser light?
3. What are the characteristics of laser?
4. What are the applications of laser?

1. Expected Value or Theoretical Values

2. Achieved Value or Experimental Value

3. Error Value

4. Reasons for Error

5. Suggestions for Error

ENGINEERING PHYSICS LAB

EXPERIMENT 9

OPTICAL FIBER - BENDING LOSSES

AIM:

To determine the losses in optical fibers in dB due to macro bending of the Fiber

APPARATUS:

Fiber Optic Kit, Optical cable of length 1m and 5m, mandrel, connecting wire.

THEORY:

The transmission loss or attenuation of an optical fiber is perhaps the most important characteristic of the fiber. Attenuation result from mainly scattering and absorption of light. Attenuation also results from number of effects like, fiber bending, fiber joints, improper cleaving and also splicing due to axial displacement and mismatch of core diameters of fibers. But, here we study the attenuation due to macro bending in fibers.

Attenuation is measured in decibels per kilometer (dB/Km), which is a logarithmicunit.

Loss of optical power = $-10/L \log (P_o/P_f)$ dB/m

Where P_o = Power launched in to the fiber
P_f = Power reached at the end of the fiber
L = Length of the given optical fiber

PROCEDURE:

1. Connect one end of the 1m optical fiber cable (OFC) to output end of the LED and the other end to the photo detector (PIN diode). Switch on thepower.
2. Turn the SET P_o knob clock wise a little. Insert the leads of the dB meter at the output terminals of the optical power meter circuit and then note the output power (P_o) in the dBmeter.
3. Without disturbing the SET P_o knob, wind the OFC one turn on the mandrel and measure the output power (P_B) in the dBmeter.
4. Repeat the above step for II turns, III turns and IV turns and note the corresponding values in table from dBmeter.
5. The difference between P_o and P_B gives the bending losses for 1mcable.
6. Repeat the same procedure for 5mOFC.

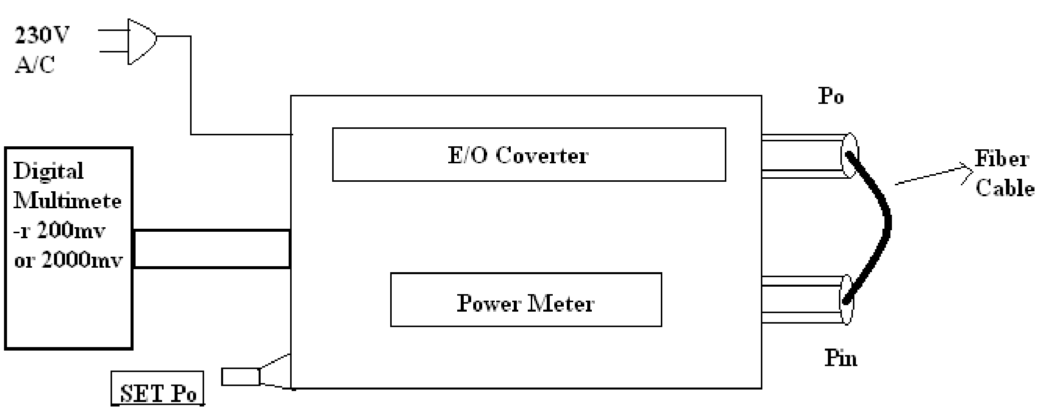


Fig: 1 Bending losses measurement

OBSERVATION TABLE:

S. No	Power without bending P_o	POWER WITH BENDING P_B		Bending Loss $P_o - P_B$
1 m		I TURN		
		II TURN		
		III TURN		
		IV TURN		
5 m		I TURN		
		II TURN		
		III TURN		
		IV TURN		

PRECAUTIONS:

1. Avoid bends in thecable.
2. Avoid cracks in thecable.

RESULT:

The Bending Losses in 1m OFC = -------------------- dB

The Bending Losses in 5m OFC = -------------------- Db

VIVA QUESTIONS:

1. What are the various types of opticalfibers?
2. What is meant by numericalaperture?
3. What is acceptanceangle?
4. What makes an optical fiber free fromEMI
5. What is total internalreflection?
6. What is the importance of cladding in an opticalfiber?
7. What are the different types of losses in the opticalfibers?

1. Expected Value or Theoretical Values
2. Achieved Value or Experimental Value
3. Error Value
4. Reasons For Error
5. Suggestions For Error

ENGINEERING PHYSICS LAB

Experiment No.10

NUMERICAL APERTURE

AIM : To determine the numerical aperture (NA) of the given optical fiber.

APPARATUS : One or two meters of the step index fiber, Fiber optics kit, and scale.

THEORY : The numerical aperture of an optical fiber is a measure of the light collected by it. It is defined as the product of the refractive index of the surrounding medium and the Sine of the maximum ray angle (acceptance angle)

Numerical aperture (NA) = $n_0 \sin\theta_a$ -----------(1)

For air as surrounding medium $n_o = 1$

And NA=Sinθ_a -----------(2)

For a step index fiber, NA is given by

NA = $[n_1 - n_2]^{1/2}$ -----------(3)

Where n_1 and n_2 are refractive indices of core and cladding materials.

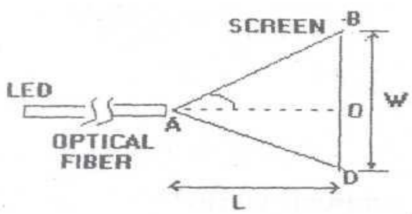


FIG. 1

Light from the fiber end ' A ' falls on the screen BD. Let the diameter of the light falling on the screen BD = w (Fig. 1)

Let the distance between the fiber and the screen AO = L From the triangle AOB

$\sin\theta_a = OB/AB$

$= OB / (OA^2 + OB^2)^{1/2}$

$= (w/2) / (L^2 + w^2 / 4)^{1/2}$

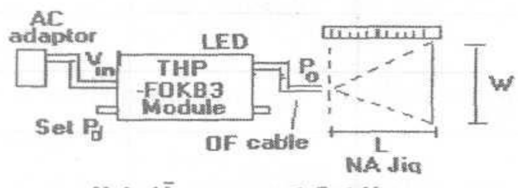
$\sin\theta_a = w/ (4L^2 + w^2)^{½}$

NA = Sinθ_a = w/ (4L^2 + w^2)$^{1/2}$ …………………(4)

Knowing w and L, the NA can be calculated and substituting this NA value in equation (2) the acceptance angleθ_a can be calculated.

PROCEDURE:

To determine the NA of a optic fiber (OF) make the connection as shown in the fig.2



1. Connect one end of the OF cable to Po and another end to the NA jig (i.e. Landing o/p of LED into OF cable).
2. Connect power adapter into socket V_{in} and plug the AC mains. Red light should appear at the end of the fiber on the NA jig. To set maximum output turn the SET Po/IF Knob clockwise. The red light intensity should increase.
3. Hold the acrylic white screen which has printed scale at a distance of 10 mm (L) from the emitting fiber end and you will view the red spot on the screen.Measure the diameter w of the spot.
4. If the intensity within the spot is not evenly distributed, wind three turns of the fiber on the mandrel.
   Substitute the measured values L and w in the formula

$$\mathbf{NA = Sin\theta_a = w/ (4L^2 + w^2)^{1/2}}$$

And calculate the value of the numerical aperture of the fiber.
Repeat the experiment for the distances of 15mm, 20 mm, 25 mm and 30 mm
And note the readings in table.

TABULAR COLUMN:

Sl.No	L (mm)	W (mm)	NA	θ_a (Degrees)
1				
2				
3				
4				
5				

RESULT: Numerical Aperture NA =

MODEL VIVA QUESTIONS:-

1. What is the principal involved in the propagation of light in the optical fibers? Explain.
2. Explain the physical significance of the numerical aperture.
3. Define the core and cladding? Explain the role of the core and cladding in the optical fiber communications.
4. What is optical fiber?
5. What is the reflection and refraction?
6. Define the band width of optical fiber.
7. Why optical fiber is suitable for communication?
8. What is the significance of cladding in optical fibers?
9. How does the fiber core diameter influence the NA?
10. Explain total internal reflection.